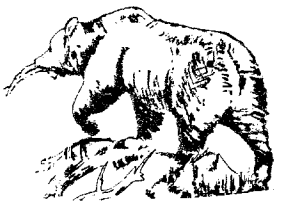
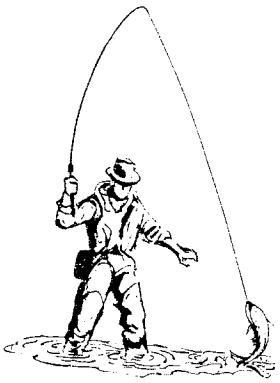
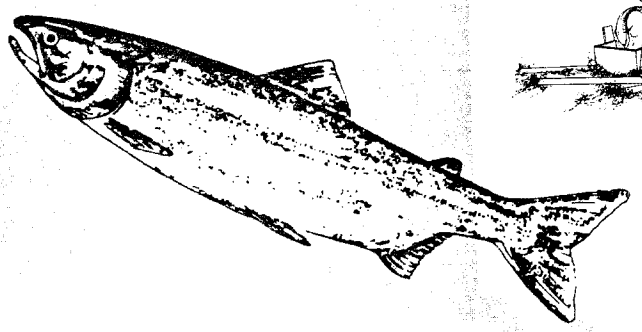
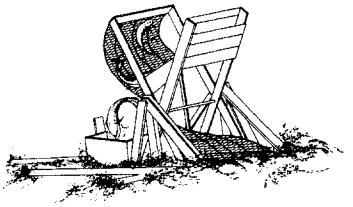
Alaska Fisheries Technical Report Number 21

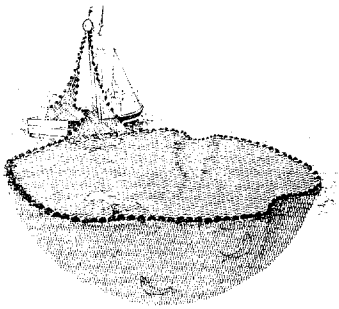
SALMON RESOURCES OF THE SWANSON RIVER WATERSHED, KENAI NATIONAL WILDLIFE REFUGE, ALASKA. 1988 and 1989











October 1993

Region 7
U.S. Fish and Wildlife Service • Department of the Interior

SALMON RESOURCES OF THE SWANSON RIVER WATERSHED, KENAI NATIONAL WILDLIFE REFUGE, ALASKA, 1988 and 1989

Ray N. Jones
David A. Faurot
and
Douglas E. Palmer

U.S. Fish and Wildlife Service
Kenai Fishery Resource Office
P.O. Box 1670
Kenai, Alaska 99611

October 1993

Disclaimer

The mention of trade names or commercial products in this report does not constitute endorsement or recommendation for use by the federal government.

The correct citation for this report is:

Jones, R.N., D.A. Faurot and D.E. Palmer. 1993. Salmon resources of the Swanson River watershed, Kenai National Wildlife Refuge, Alaska, 1988 and 1989. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report Number 21, Kenai, Alaska.

Abstract

The Swanson River is located in the northern part of the Kenai National Wildlife Refuge and drains into Upper Cook Inlet. A survey of anadromous fish populations was conducted in the watershed during 1988 and 1989 to provide baseline information for resource management and to assess potential impacts from public use and encroaching development. A portable picket weir was operated during both years to determine the abundance and run timing of adult salmon *Oncorhynchus* spp. Ground surveys were conducted in the mainstem river and 38 headwater lakes to evaluate spawning distribution and estimate spawning escapements in Gruska and Sucker creeks. An inclined plane trap was operated downstream of the weir site during 1988 to determine the timing, size composition, and age structure of outmigrating salmon smolts.

Four species of salmon returned to the Swanson River in 1988 and 1989. In 1988, 23,514 coho *O. kisutch*, 1,542 sockeye *O. nerka*, 72 pink *O. gorbuscha*, and 5 chinook salmon *O. tshawytscha* migrated upstream through the weir. In 1989, only coho salmon were monitored; 20,841 fish passed the weir from 30 July to 27 August, when operations were suspended due to heavy rain and high water levels. Escapements of coho salmon were 10-100 times greater than previous weir counts conducted during the 1960's.

In 1988, sockeye salmon passed through the weir from 4 June to 22 September and peak numbers of early-run and late-run fish occurred in late June and early August, respectively. Coho salmon were observed at the weir from 16 July to 26 September and peak numbers occurred the third week of August. The majority of sockeye salmon (77%) sampled in 1988 spent two winters at sea compared to one year at sea for most coho salmon (97%).

Salmon spawning areas were more widespread than previously documented and were found throughout the drainage at both mainstem and tributary locations. Mainstem spawners included sockeye salmon which spawned primarily in the vicinity of the two oil field bridges and pink salmon which spawned in the lower reaches near the weir. Coho salmon spawned primarily in the inlets or outlets of 14 headwater lakes. Coho salmon spawning escapements into Sucker and Gruska creeks were estimated at 3,654 and 3,676 fish, respectively, using the "Factor 5" method.

The outmigration of salmon smolts occurred primarily during June and July. Most age 2 and 3 sockeye salmon outmigrated during early June, whereas, age 1 fish outmigrated primarily during late June and July. The majority of coho salmon smolts outmigrated during early June, however, age 1 fish tended to smolt later than older fish. Seventy-one percent of the sockeye salmon (N=834) smolted at age 1, whereas 67% of the coho salmon (N=319) smolted at age 2.

Table of Contents

List of Tables

List of Figures

List of Appendices

Introduction

Salmon resources are important to commercial and recreational fisheries in the Upper Cook Inlet Region. The Swanson River, a major river originating on the Kenai National Wildlife Refuge (Kenai Refuge) and entering Upper Cook Inlet (Figure 1), contributes to these fisheries. Several anadromous fish species occur in this watershed, however, escapement and other life history information is lacking.

The Alaska Department of Fish and Game (Department) has included the Swanson River watershed in some of their anadromous fish surveys. The Department operated a weir on the Swanson River from 1962 to 1967 to evaluate the river as a potential egg source for coho salmon *Oncorhynchus kisutch* (Lawler 1963; Engel 1966, 1967, 1968). Escapement estimates of coho salmon ranged from 239 to 2,043, but these estimates were considered low because the weir was operated for varying lengths of time each year and portions of the run were missed during some years. During the 1960's, the Department conducted spawning ground surveys on Gruska and Sucker creeks, two tributaries to the Swanson River (Lawler 1963; Engel 1967; Logan 1970). Counts of coho salmon using these streams ranged as high as 279 and 499 for Gruska and Sucker creeks, respectively. Spawning survey estimates of these streams in the 1970's ranged as high as 370 fish (U.S. Fish and Wildlife Service, unpublished data). Other salmon species which have been documented in the Swanson River drainage, but for which little information exists, include sockeye *O. nerka*, pink *O. gorbuscha* and chinook *O. tshawytscha* salmon (Engel 1968; Alaska Department of Fish and Game 1983).

The Swanson River, with its tributaries and lakes, is the second most popular watershed on the Kenai Refuge. Opportunities for fishing, hunting, canoeing, and camping in a wilderness setting cause the Swanson River watershed to receive extensive public use. Anadromous and resident fish species are targeted by anglers in a growing recreational fishery. The annual harvest of coho salmon from the Swanson River drainage averaged 2,351 fish from 1983 to 1990 (Mills 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991). The number of days fished has increased from 2,124 in 1983 to 8,578 in 1990 (Mills 1984, 1991). Fishery resources in the drainage also support local populations of piscivorous wildlife such as brown and black bears *Ursus* spp., mergansers *Mergus* spp., and bald eagles *Haliaetus leucocephalus*.

A major feature of the Swanson River watershed is the Swanson River Oil Field (Figure 2). The Swanson River Oil Field, found in 1957, was the first substantial oil discovery in Alaska (U.S. Fish and Wildlife Service 1985). That discovery developed into a major oil and natural gas field which, to date, has produced over 200 million barrels of oil. Nearly 100 wells have been drilled on this 3,200-hectare field and numerous support facilities have been built, including over 53 km of access roads. Development of oil and gas resources in the Swanson River drainage could, without adequate safeguards, impact refuge habitats and fish populations.

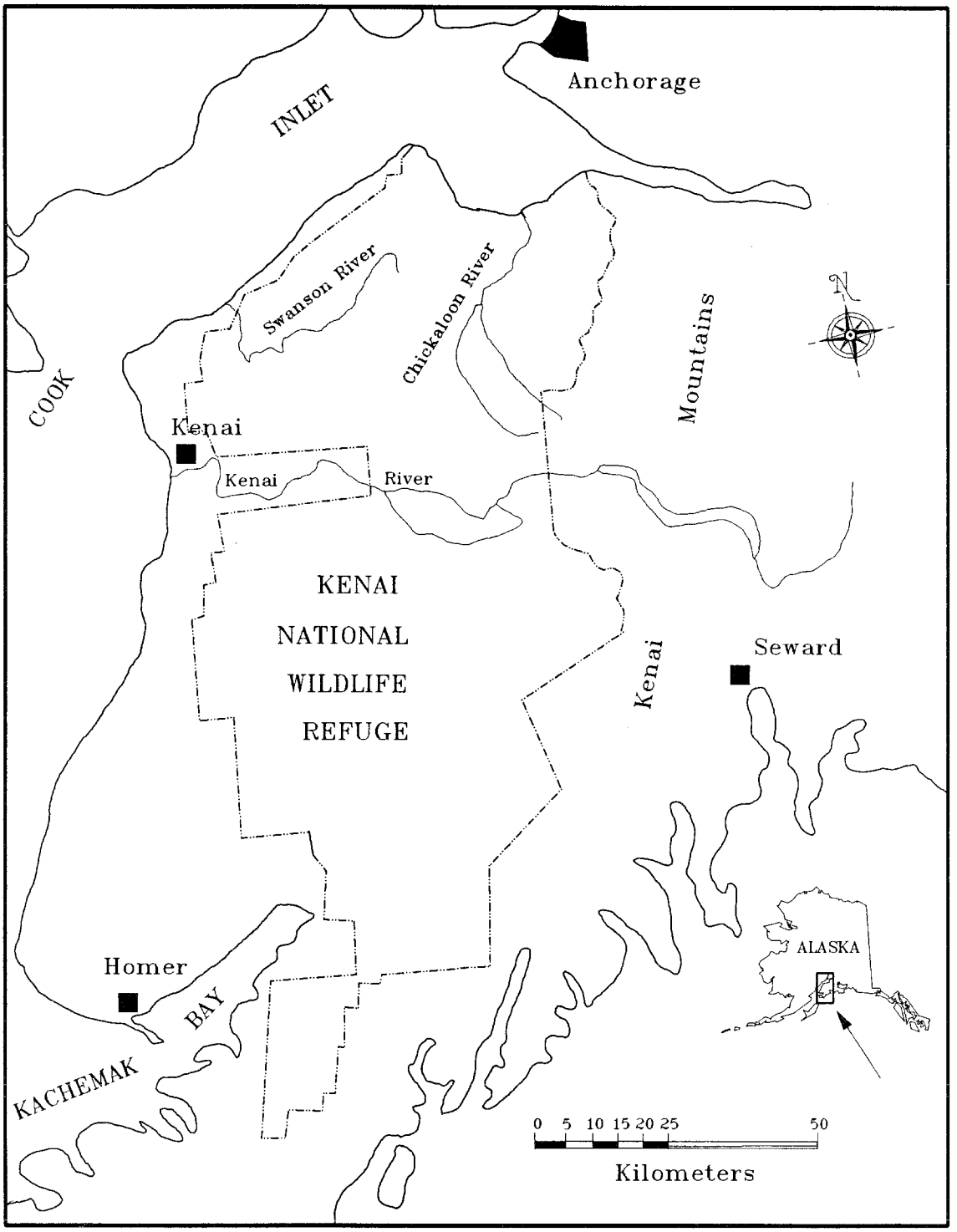


FIGURE 1.-Location of the Swanson River in the Kenai National Wildlife Refuge, Alaska.

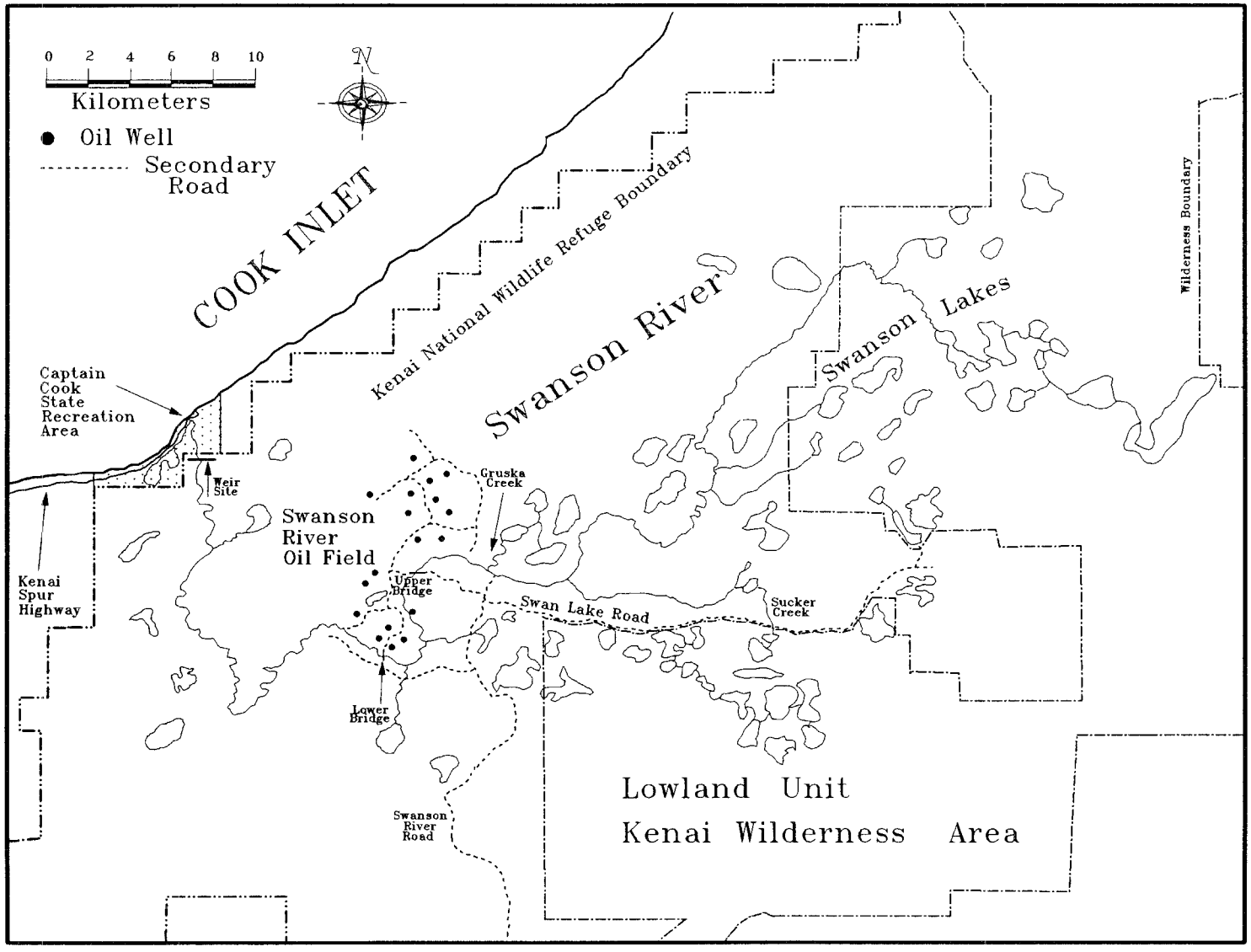


FIGURE 2.—Major features of the Swanson River watershed, Kenai National Wildlife Refuge, Alaska.

To provide baseline information for resource management and to assess potential impacts from public use and encroaching development, a survey of the fishery resources in the Swanson River watershed was conducted during 1988 and 1989. The scope of this two-year project included investigations of anadromous and resident fish species, public use, and fish harvest. Because of the wide scope of the project, results have been separated into three reports, each dealing with a different aspect of the fishery resource. This report presents data collected on adult and juvenile anadromous fishes in the Swanson River watershed during 1988 and 1989. Specific objectives were to: 1) determine the abundance, run timing, size composition, age structure, sex ratio, and spawning distribution of adult salmon *Oncorhynchus* spp.; and, 2) determine the outmigration timing, size composition, and age structure of juvenile salmon.

Study Area

The Swanson River, located in the northwestern portion of the Kenai Peninsula, originates in the Swanson Lakes area and encompasses about 717 km^2 (Figure 1). Approximately 99% of the Swanson River watershed lies within the Kenai National Wildlife Refuge with the headwaters located in the Lowland Unit of the Kenai Wilderness Area (Figure 2). The lower 1.9 km of the river flows through the Captain Cook State Recreation Area and into Cook Inlet.

The Swanson River watershed is part of the Kenai Lowlands, a region of flat to gently rolling terrain occupying an ancient glacial lake bed. The area is characterized by a widely interconnected network of mostly abandoned muskeg-filled drainages and a series of muskeg covered terraces (Karlstrom 1964).

Because elevations in the watershed range from 15 to 90 m, the Swanson River is shallow and meanders extensively throughout most of its course. The mainstem is about 77 km in length and has an average gradient of 0.8 m/km. Stream gradients range from 0.3 m/km in the upper reaches to 1.4 m/km in the lower 6 km of the river. The average, maximum, and minimum discharges measured near river kilometer (rkm) 2, from 12 June 1987 to 22 June 1989, were 6, 45, and 1.5 m^3/s, respectively (Inghram and Ireland 1990).

The Swanson River watershed contains more lakes than any other watershed on the refuge, with over 1,000 lakes ranging from three to 350 hectares in size. More than 50 of these headwater lakes were set aside to form two National Recreation Trails, the Swanson River and Swan Lake canoe routes.

Access to the upper Swanson River is provided by the Swanson River Road, a secondary road located about 34 km east of Kenai near Sterling, Alaska. The lower river is accessed by the Kenai Spur Highway which terminates at Captain Cook State Recreation Area (Figure 2).

Methods

Adult Salmon

Abundance and run timing.-A 24-m picket weir was operated at rkm 3.3 to determine the abundance and run timing of adult salmon returning to the Swanson River (Figure 2). The weir was designed from models previously built by the Department (Jackson 1983). A 4-m^2 trap and holding area were constructed into the face (upstream side) of the weir to facilitate sampling fish and passing adult salmon through the weir. Individual weir pickets were spaced approximately 3 cm apart, requiring adult salmon of all species to pass through the trap.

The weir was operated from 21 May to 26 September in 1988 to monitor all salmon species returning to the Swanson River. In 1989, the weir was operated from 12 July to 27 August to monitor returning coho salmon. Operations were suspended 28 August in 1989 because of heavy rain and high water.

Salmon were allowed to enter the trap until it reached capacity (about 50-75 fish) and then fish were individually identified, counted, and released upstream. When large numbers of salmon began to accumulate downstream of the weir, one or two pickets were removed from the weir and the salmon were identified and counted as they passed through.

Age, length, and weight.-A daily sample of up to 15 salmon of each species were randomly selected for collection of biological data in 1988. Mideye to fork length was measured to the nearest 5 mm and weights were measured to the nearest 25 g. Sex was determined using external characteristics and scales were collected from sockeye and coho salmon. Scales were removed from the preferred area for age determination (Ambrose 1983). Age designation followed Koo (1962), where the initial numeral indicates the number of winters of freshwater life and the second indicates the number of winters of saltwater life. The same procedures were used for coho salmon in 1989 except that 10 fish or less were sampled daily. Chi-square tests (Zar 1984) were used to test for significant differences in sex ratios and age composition.

Spawning distribution.-The spawning distribution of adult salmon in the Swanson River was investigated by ground surveys of the Swanson River mainstem and the inlets and outlets of 38 headwater lakes connected to the mainstem Swanson River. Inlets and outlets of 24 headwater lakes were surveyed once and the remaining areas were surveyed as many as 10 times between 10 June and 9 December. A stream reach was identified as a spawning area if fish were observed exhibiting spawning behavior or if carcasses were present. The number of spawning salmon observed and carcasses were recorded for each salmon species.

Spawning escapement in Gruska and Sucker creeks.-Previous spawning surveys of coho salmon indicated that Gruska and Sucker creeks are important spawning areas for coho salmon in the Swanson River watershed (Lawler 1963; Engel 1967; Logan 1970; U.S. Fish and Wildlife Service,

unpublished data). Accordingly, spawning escapements of coho salmon into these streams were estimated using the "area under the curve" method (Ames 1984) and the "Factor 5" method (Cousens et al. 1982). The following formula was used for the "Factor 5" method:

$$R = MD/T;$$

R = total number of spawners utilizing a given stream section;
M = average of several live counts through the spawning period including the peak;
D = length of time (days) fish are present in the stream;
T = average redd life (days) of individual fish after reaching the stream section.

A redd life of nine days was assumed for both streams based on data from Sashin Creek in Southeastern Alaska (Crone and Bond 1976).

Juvenile Salmon

Outmigration timing.-An inclined plane trap was installed in the Swanson River approximately 20 m downstream from the weir to determine the timing of outmigrating salmon smolts. The trap was operated from 21 May-10 August and 18-23 September in 1988. The design was identical to models previously built by the Department (Flagg et al. 1985). The trap was operated 24 h/d and was checked daily at 0900 hours. All fish in the holding box were identified and counted.

Age, length, and weight.-A daily sample of up to 20 fish of each species was removed from the inclined plane trap and anesthetized with tricaine methane sulfonate (MS-222) to facilitate handling. Fish were measured to fork length (nearest mm), weighed (nearest g), and scales were collected. Scales were taken from the left side above the lateral line and below the posterior insertion of the dorsal fin. Scales were mounted between glass slides and examined with a microfiche reader to determine age.

Results

Adult Salmon

Abundance and run timing.-Four species of Pacific salmon returned to the Swanson River in 1988: 23,514 coho, 1,542 sockeye, 72 pink, and 5 chinook salmon. In 1989, 20,841 coho salmon were counted before weir operations were suspended on 28 August due to high water. Other species collected in the trap included 15 rainbow trout *Oncorhynchus mykiss*, 3 Dolly Varden *Salvelinus malma*, and 5 longnose sucker *Catostomus catostomus*. Daily counts are listed in Appendix 1.

In 1988, sockeye salmon were first observed at the weir in early June and were passed upstream through mid-September (Figure 3). A bimodal distribution was observed with peak numbers of early-run and late-run sockeye salmon occurring the last week in June and the first week in

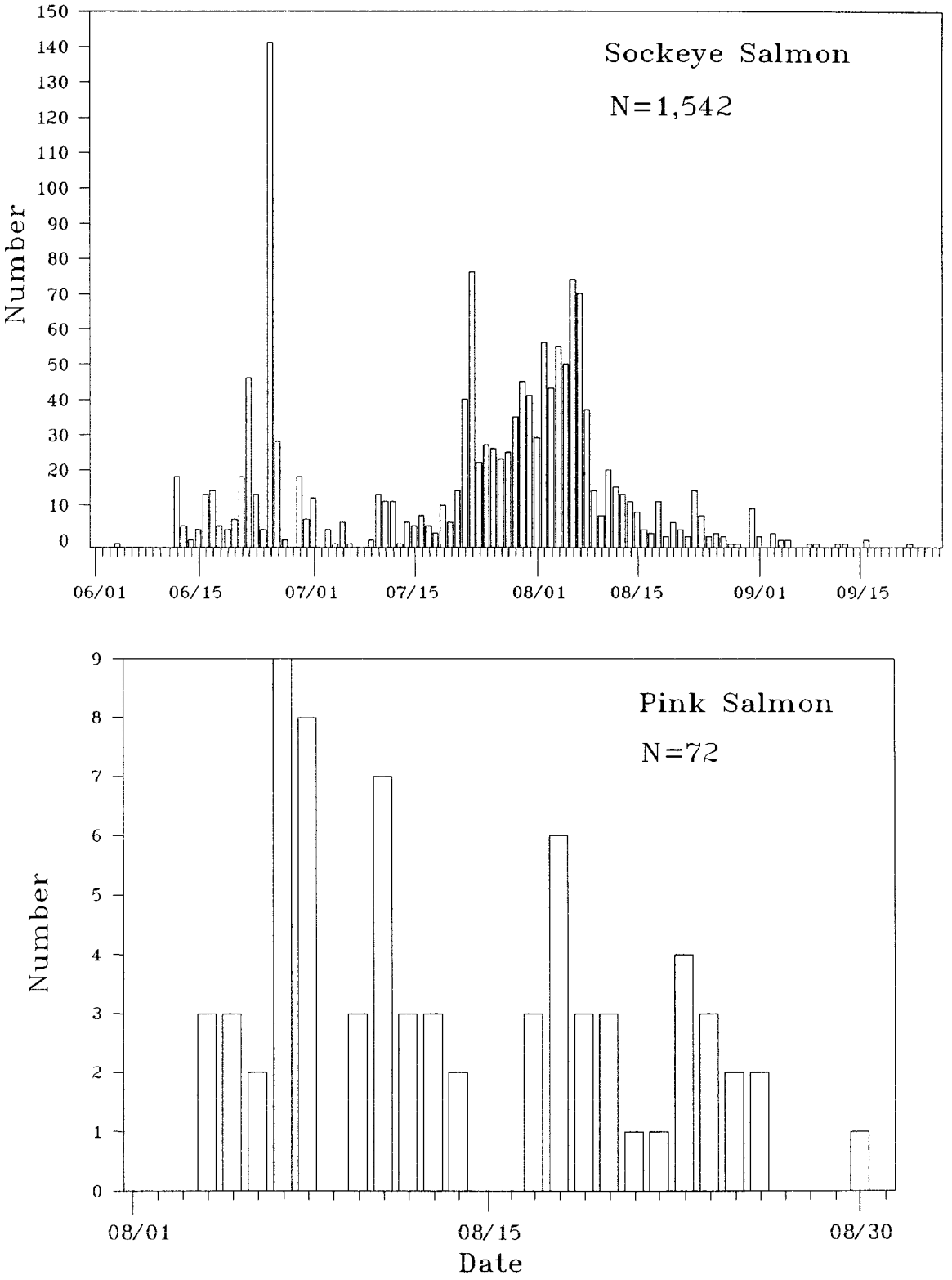


FIGURE 3.-Daily escapement of adult sockeye and pink salmon, Swanson River, Alaska, 1988.

August, respectively. Pink salmon migrated upstream between 4 and 30 August with a peak of 9 fish occurring on 7 August (Figure 3). Coho salmon first appeared at the weir on 16 July and were observed through 26 September (Figure 4). The peak of the run occurred the third week in August and about 98% of the run had passed the weir by 15 September. Five chinook salmon passed through the weir between 27 and 30 June.

In 1989, coho salmon first appeared at the weir on 30 July, eight days later than in 1988 (Figure 4). As in 1988, the highest daily count occurred on 22 August. A daily total of 2,208 coho salmon migrated through the weir on 27 August, one day before operations were suspended due to heavy rains and high water.

Age, length, and weight.-Seven age groups of sockeye salmon were identified in 1988 (Table 1). Age group 2.2 dominated the sample (57%) followed by ages 1.2 (19%) and 1.3 (17%). Age composition differed significantly between males and females ($P<0.001$). Age 2.2 was the dominant age group for both sexes, but this age group was much more dominant in females (67%) than in males (40%). The percentage of females (63%) differed significantly from the percentage of males ($P<0.001$). The average length of males and females was identical, however, males averaged about 200 g heavier than females.

Six age groups of coho salmon were identified in 1988 and three in 1989 (Table 2). The dominant age group was 2.1 for males and females both years. The percentage of females during 1988 (50.7%) and 1989 (48.2%) did not differ significantly from the percentage of males ($P>0.50$ for both years). Coho salmon averaged 577 mm (N=760) and 554 mm (N=222) in length and 3,584 g and 3,336 g in weight in 1988 and 1989, respectively.

Pink salmon had a mean length of 448 mm, a mean weight of 1,433 g and a 1:1 sex ratio (N=12).

Spawning distribution.-Adult sockeye salmon spawned primarily in the vicinity of the two Swanson River Oil Field bridges on the mainstem river during late July and early August (Figure 2). A peak count of 130 fish was observed on 28 July (Appendix 2). In addition, three adult sockeye salmon were observed in the outlet of Gruska Lake and two were captured in a gill net set in Wilderness Lake.

Coho salmon were observed in inlets or outlets of 14 lakes and at Swan Creek (Appendix 2). Major spawning areas ($\geq$20 fish) included the outlets of Canoe Lake 1, Canoe Lake 2, Contact, Doghouse, McLain, Merganser, Snipe, Sucker, Gruska, Gene, and Wild lakes, and Swan Creek (Figure 5).

The only locations where pink salmon were observed spawning were immediately upstream and downstream of the weir.

Spawning escapement in Gruska and Sucker creeks.-Spawning populations of coho salmon in Sucker and Gruska creeks during 1988 were nearly

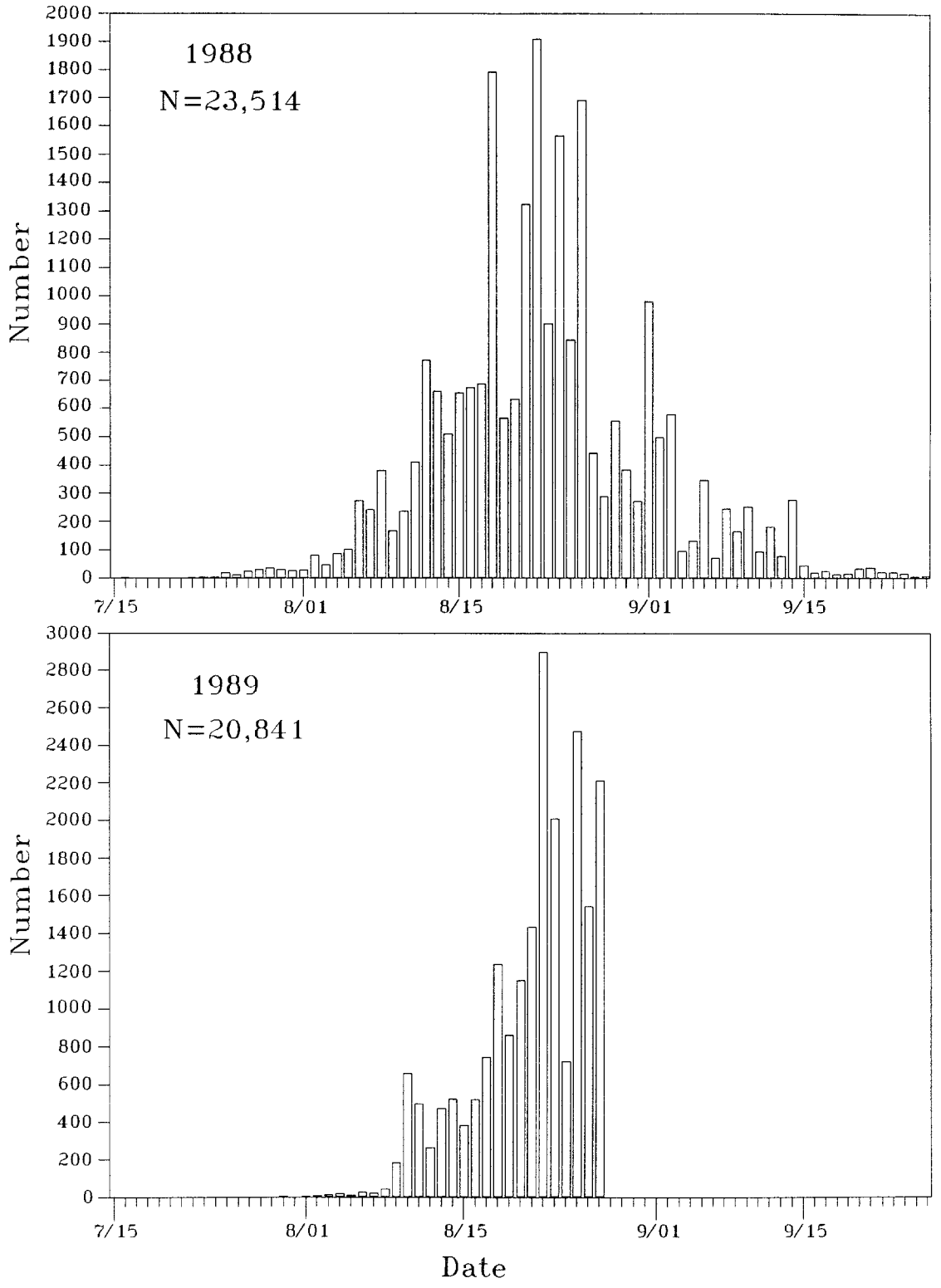


FIGURE 4.-Daily escapement of adult coho salmon, Swanson River, Alaska, 1988 and 1989.

TABLE 1.—Age, length, and weight composition of sockeye salmon sampled at the Swanson River weir, Alaska, 1988.

	Females						Males					
			Length (mm)		Weight (g)				Length (mm)		Weight (g)	
Age	N	%	Mean	SE	Mean	SE	N	%	Mean	SE	Mean	SE
1.1	2	0.4	480	30	1,575	325	5	0.9	367	13	880	82
1.2	47	8.3	442	6	1,472	83	60	10.5	444	7	1,516	75
1.3	50	8.8	521	4	2,166	53	47	8.3	543	3	2,647	53
2.1	4	0.7	416	25	1,150	207	12	2.1	414	15	1,063	140
2.2	240	42.2	502	2	1,796	21	86	15.1	521	4	2,184	50
2.3	6	1.1	528	6	2,088	120	3	0.5	546	13	2,667	262
3.2	7	1.2	475	14	1,643	106	0	0	-	-	-	-
Total	356	62.7	495		1,799		213	37.4	495		2,011	

TABLE 2.—Age, length, and weight composition of coho salmon sampled at the Swanson River weir, Alaska, 1988 and 1989.

	Females						Males					
			Length (mm)		Weight (g)				Length (mm)		Weight (g)	
Age	N	%	Mean	SE	Mean	SE	N	%	Mean	SE	Mean	SE
						1988						
1.1	82	10.8	568	6	3,316	92	104	13.7	569	5	3,470	86
2.0	0	-	-	-	-	-	5	0.7	310	6	585	31
2.1	256	33.7	591	3	3,684	45	221	29.1	589	4	3,848	58
3.0	0	-	-	-	-	-	14	1.8	324	5	652	27
3.1	47	6.2	591	6	3,701	99	30	3.9	584	10	3,689	186
4.0	0	-	-	-	-	-	1	0.1	310	-	750	-
Total	385	50.7	586		3,608		375	49.3	569		3,559	
						1989						
1.1	28	12.6	541	9	3,059	161	33	14.9	552	7	3,293	158
2.1	68	30.6	544	5	3,122	95	76	34.2	569	4	3,609	92
3.1	11	5.0	555	15	3,261	268	6	2.7	583	15	3,958	368
Total	107	48.2	544		3,120		115	51.8	565		3,537	

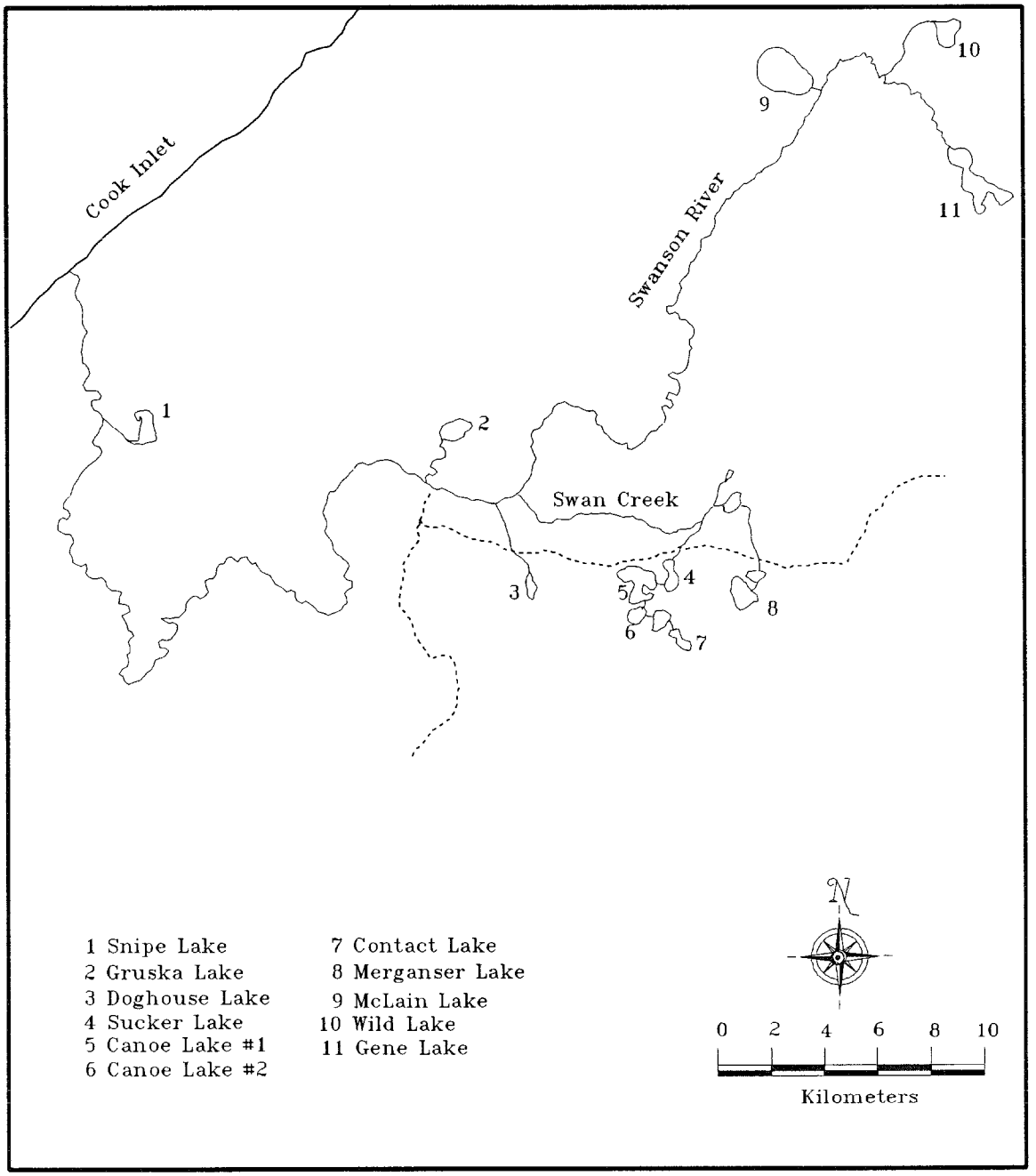


FIGURE 5.-Lakes having inlets or outlets that are major spawning areas of coho salmon in the Swanson River watershed, Alaska.

identical with estimates of 3,654 and 3,676 fish, respectively, using the "Factor 5" method. Estimates using the "area under the curve" method were comparable at 3,896 fish for Sucker Creek and 3,412 fish for Gruska Creek. Spawning in these streams was first observed on 19 September and continued until freeze-up in November (Gruska Creek) and December (Sucker Creek). Peak spawner counts occurred on 11 October for both streams.

Juvenile Salmon

Outmigration timing.-A total of 3,204 sockeye, 1,064 coho, and three chinook salmon juveniles were collected in the inclined plane trap in 1988. Daily counts of each species are listed in Appendix 3. Most sockeye salmon smolts were collected between 21 May and 10 August. Only three were collected between 18 and 23 September. Daily counts showed two distinct groups of outmigrating sockeye salmon smolts. A smaller group outmigrated between 21 May and 16 June with the peak occurring on 9 June (Figure 6). This group consisted almost entirely of age 2 and 3 fish (Figure 7). The larger group outmigrated between 18 June and 10 August with the peak occurring on 27 June. This group consisted almost entirely of age 1 fish.

The majority of coho salmon smolts were collected between 31 May and 10 August with only four collected between 18 and 23 September. Most had outmigrated by the middle of June with the peak occurring between 1 and 9 June (Figure 6). Older age groups of smolts tended to outmigrate earlier than younger age groups, although considerable overlap occurred (Figure 8).

Age, length, and weight.-Age groups 0, 1, 2, and 3 were represented for both sockeye and coho salmon smolts (Table 3). Sockeye salmon outmigrants were mostly age 1 (71%) and age 2 (22%). For coho salmon, age 2 (67%) and age 3 (25%) were the dominant outmigrants.

TABLE 3.-Age, length, and weight composition for coho and sockeye salmon smolts sampled from the inclined plane trap, Swanson River, Alaska, 1988.

				Length (mm)		Weight (g)	
Species	Age	N	%	Mean	SE	Mean	SE
Coho	0	1	0.3	49		1.2	
salmon	1	23	7.2	79	2	5.3	0.4
	2	214	67.1	124	1	20.2	0.4
	3	81	25.4	138	1	27.4	0.8
Sockeye	0	15	1.8	54	3	1.5	0.3
salmon	1	589	70.5	73	1	3.6	0.1
	2	185	22.2	130	1	22.7	0.6
	3	46	5.5	154	2	36.5	1.7

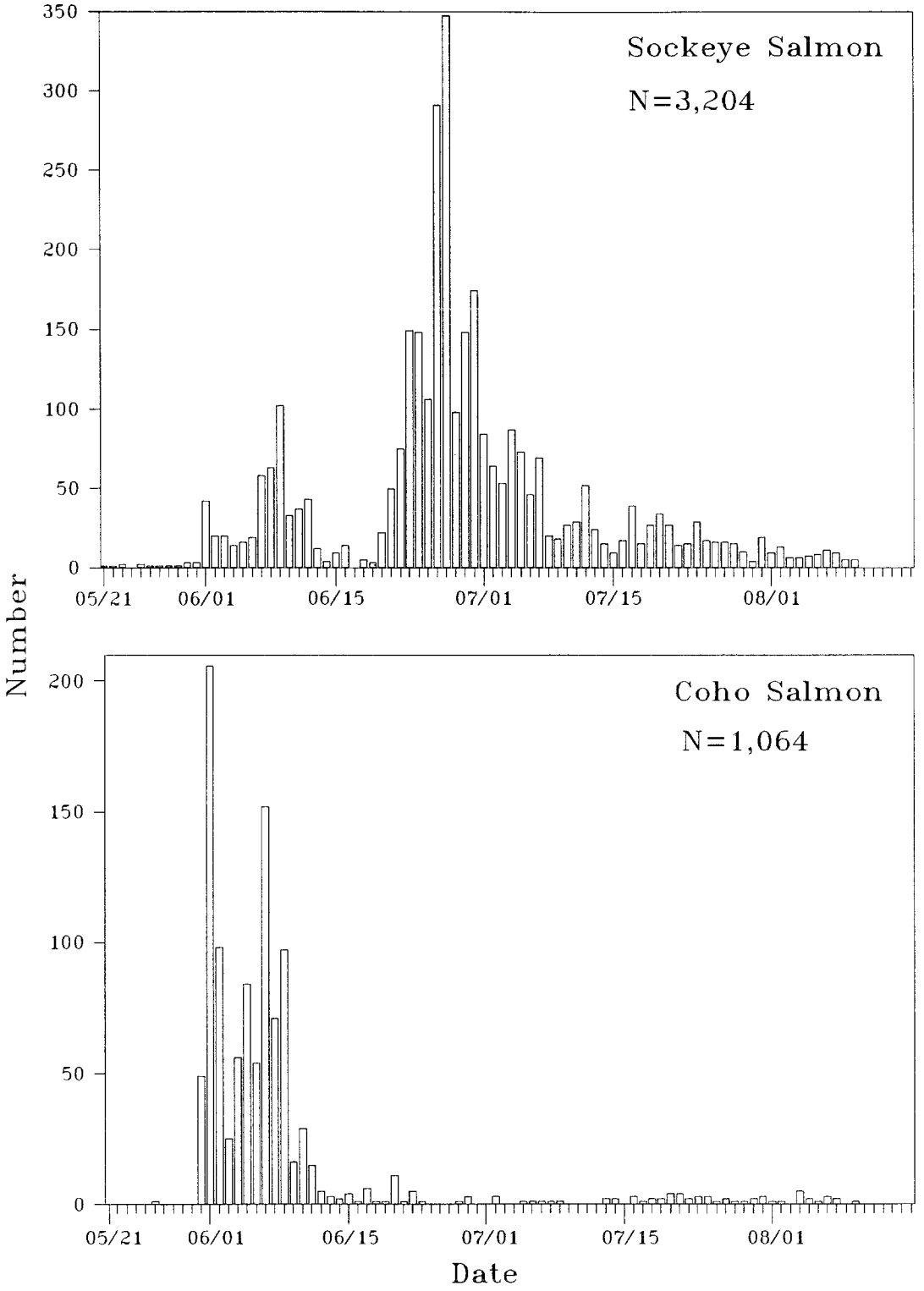


FIGURE 6.-Outmigration timing of sockeye and coho salmon smolts collected in the inclined plane trap, Swanson River, Alaska, 1988.

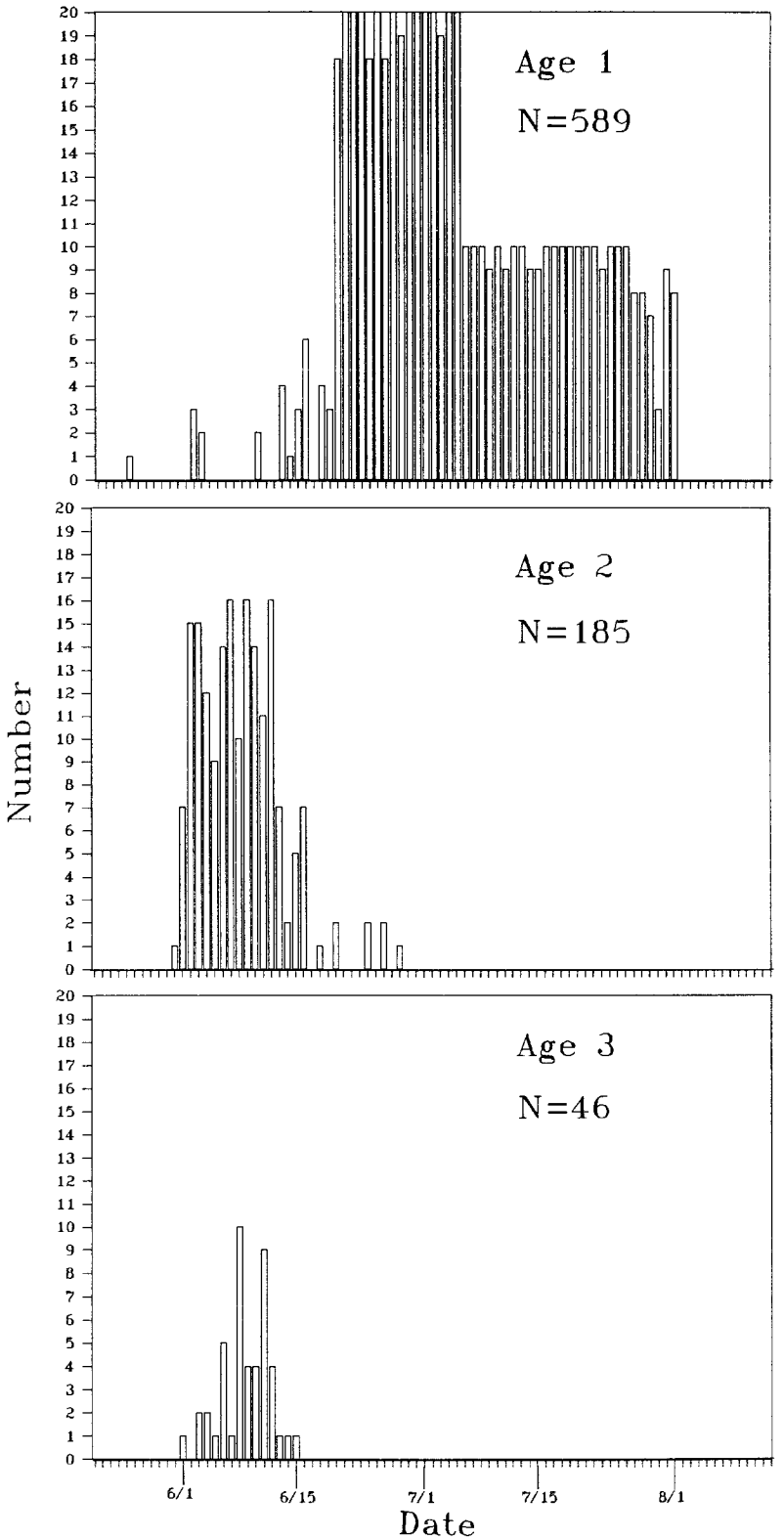


FIGURE 7.-Outmigration timing of sockeye salmon smolts by age group, Swanson River, Alaska, 1988.

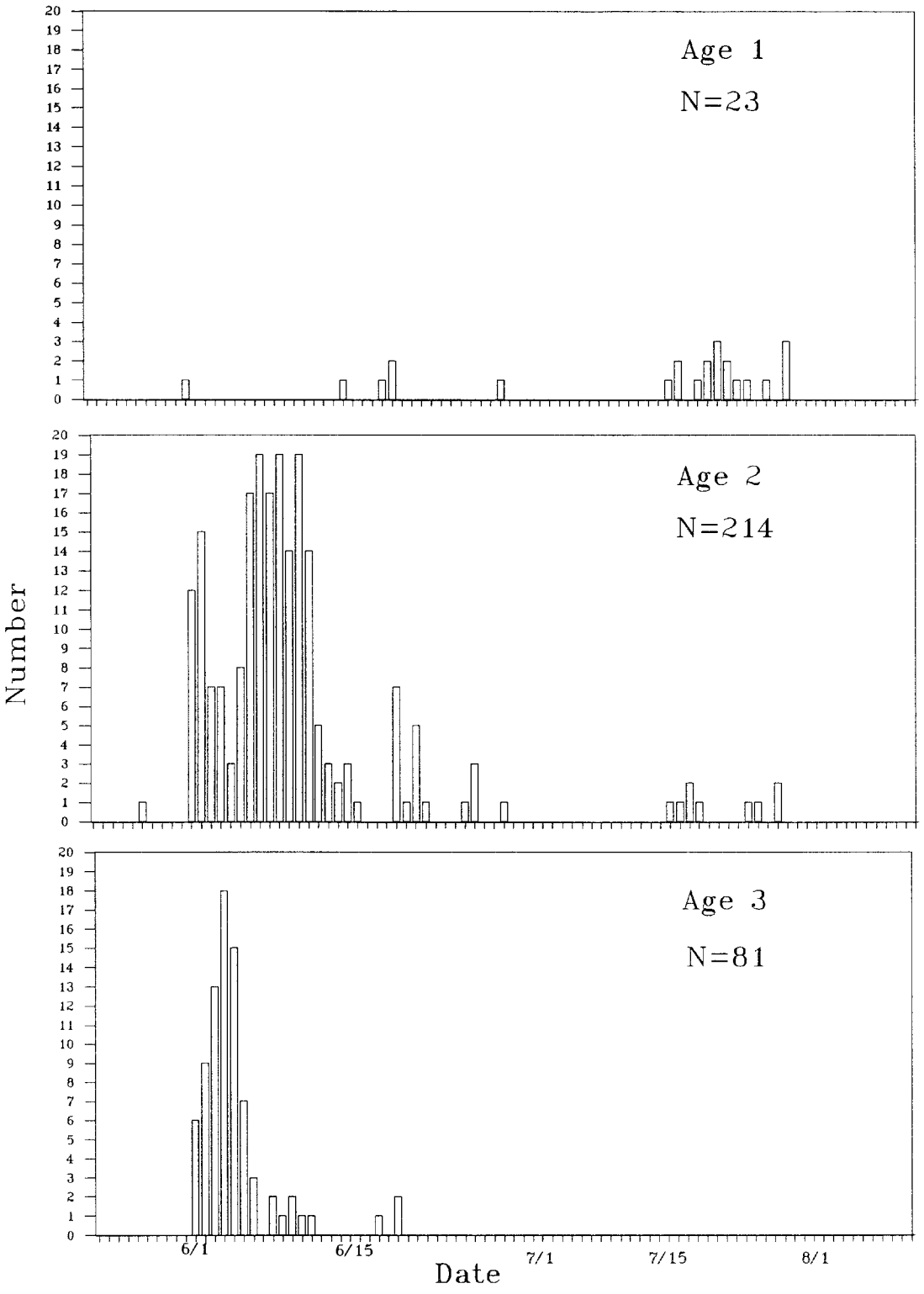


FIGURE 8.-Outmigration timing of coho salmon smolts by age group, Swanson River, Alaska, 1988.

Discussion

Adult Salmon

Abundance and run timing.-Four species of salmon were found in the Swanson River with coho salmon being the most abundant. These findings are generally consistent with previous weir counts available for the Swanson River (Lawler 1963; Engel 1966, 1967, 1968). Coho salmon was the most abundant species observed at the weir operated from 1962-1967, however, the magnitude of the run was far less than observed during this study. Counts of coho salmon ranged from 239 fish in 1962 to 2,043 fish in 1965 compared to escapements of over 20,000 that we observed. One explanation for the lower escapements observed during the 1960's is that the weir was generally operated from the third week in August through mid-October and, therefore, fish returning earlier were not counted. In 1988, coho salmon returning prior to 20 August comprised 36% of the run. Despite timing differences in weir operation, it appears that coho salmon escapements observed during 1988 and 1989 are much larger than escapements which occurred in the 1960's.

Although sockeye and chinook salmon were observed during weir operations in the 1960's, these weirs were installed too late in the season to accurately assess abundance of these species. Six sockeye and one chinook salmon were enumerated at the Swanson River weir in 1967. In our study, 95% of the sockeye salmon passed the weir by 20 August. All five of the chinook salmon we observed passed the weir the last week in June, nearly two months earlier than the weirs were installed in the 1960's. The small number of chinook salmon observed in 1988 suggests that these fish were probably strays and that the Swanson River does not support a viable population of chinook salmon. No pink salmon were observed during earlier weir operations, however, we counted 72 pink salmon through the weir in 1988. The absence of pink salmon from earlier weir counts can be explained by the location of the weir. Earlier weirs were constructed in the vicinity of the lower Oil Field bridge approximately 23 km upstream of our weir location and above known pink salmon spawning areas.

The run timing of salmon in the Swanson River is very similar to that observed in other Kenai Peninsula rivers. The run timing of sockeye salmon in the Swanson River is identical to runs returning to the Moose and Russian rivers (Booth *in preparation;* Nelson et al. 1987). All three rivers have an early run which peaks between late June and early July and a late run which peaks between late July and early August.

Most coho salmon passed the weir from early August through mid-September. This is very similar to the run timing of coho salmon in the Chickaloon River (Faurot and Dean *in preparation*), but two to three weeks earlier than runs returning to the Moose and Russian rivers (Booth *in preparation;* Hammarstrom and Athons 1989). The distance each of these rivers is from Cook Inlet may explain the difference in run timing observed.

Pink salmon returned to the Swanson River primarily during August in 1988. This run timing is similar to other upper Kenai Peninsula rivers that support pink salmon (Ruesch 1991), but the small number of fish counted at the weir (N=72) in 1988 suggests that this even-year run is very small. Most upper Kenai Peninsula rivers support larger escapements of pink salmon on even-numbered years (Ruesch 1991); therefore, odd-year returns to the Swanson River would typically be weaker than the return observed in 1988. Some pink salmon were observed spawning below the weir, but an estimate of their numbers is not available.

Age, length, and weight.-The age composition of adult sockeye salmon in the Swanson River is very similar to that in the Moose and Chickaloon rivers (Booth *in preparation*; Faurot and Dean *in preparation*). In all three rivers, over 50% of the sockeye salmon spend two years in fresh water and at least two years in the ocean. In contrast, most Kenai and Kasilof River sockeye salmon spend only one year in freshwater (King and Tarbox 1989). Adult sockeye salmon in the Swanson River are only slightly smaller than those in the Moose or Kasilof rivers (Booth *in preparation*; King and Tarbox 1989) while those in the Kenai River are larger than all three (King and Tarbox 1989). The differences in age structure and size observed among these systems is likely related to rearing habitat and food supply available in glacial versus non-glacial systems. Genetic characteristics of the various strains may also explain some of the differences.

Our data on the age structure of coho salmon in the Swanson River agrees with Engel (1966, 1967, 1968) who also observed that coho salmon in the Swanson River were mostly age 2.1. Age 2.1 coho salmon are also the dominant age group in most other Kenai Peninsula rivers (Booth *in preparation*; Faurot and Dean *in preparation*; Hammarstrom and Athons 1989).

The mean length of coho salmon in the Swanson River was similar to mean lengths in the Moose and Chickaloon rivers (Booth *in preparation*; Faurot and Dean *in preparation*), but considerably less than fish returning to the Kenai River (Hammarstrom and Athons 1989). Mean lengths of coho salmon collected in the Swanson River by the Department in 1965, 1966, and 1967 were much larger than we observed, however, the difference can be attributed to sampling methods. The Department recorded fork lengths (L. Engel, Alaska Department of Fish and Game, personal communication), whereas we recorded mid-eye to fork lengths.

Spawning distribution.-Coho salmon have been observed throughout the Swanson River watershed, although only a few major spawning areas, Sucker, Canoe, and Gruska creeks, have been identified (Lawler 1963; Logan 1970). We observed adult coho salmon in 14 lake outlets, nine of which had moderate numbers of fish ($N \geq 20$). In addition, coho salmon were observed in three lake outlets not previously reported as supporting coho salmon populations: Merganser, Snipe, and Wild lakes.

Most sockeye salmon were observed spawning in the vicinity of the two Swanson River Oil Field bridges on the mainstem river. However, a few sockeye salmon were observed in Gruska and Wilderness lakes. Some lake spawning may be occurring, but the extent is unknown.

Spawning escapement in Gruska and Sucker creeks.-Spawning escapements of coho salmon in Sucker and Gruska creeks were estimated between 3,600 and 3,700 fish in each stream during 1988 using the "Factor 5" method. Although previous spawning escapement estimates for these streams do not exist, comparisons can be made with earlier survey counts. Counts on Gruska and Sucker creeks ranged from 5 to 279 fish and 29 to 499 fish, respectively, between 1964 and 1976 (Lawler 1963; Engel 1967; Logan 1970; U.S. Fish and Wildlife Service, *unpublished data*). These surveys were conducted during the period considered to be the peak of spawning. Peak counts of coho salmon in Gruska and Sucker creeks in 1988 were 1,234 and 929 fish, respectively (Appendix 2). These counts are two to four times higher than the highest counts of previous surveys, supporting the claim that coho salmon escapements during 1988 were substantially larger than escapements observed in the 1960's.

Spawning escapements of coho salmon in Gruska and Sucker creeks in 1988 may have been underestimated because stream residence time and numbers of fish observed during the last few weeks of the season were underestimated. Although our first surveys of both creeks were conducted before coho salmon started to arrive, 41 days elapsed between the last survey where no fish were observed (9 August) and the next survey (19 September), when fish were already in the streams in substantial numbers (189 in Gruska Creek and 178 in Sucker Creek). Engel (1966) reported observing coho salmon in Gruska Creek prior to 19 August 1965. Thus, the beginning of residence time could have been missed by as much as three weeks. Also, Gruska Creek became completely frozen over before the end of residence time could be determined. Ice formations along stream banks and around debris jams also made the last two surveys on Sucker Creek very difficult. Fish consistently took cover in these areas making observation and accurate counts nearly impossible.

Juvenile Salmon

Outmigration timing.-The outmigration timing of sockeye and coho salmon juveniles in the Swanson River is typical of most other Kenai Peninsula streams (Flagg et al. 1985; Todd and Kyle 1987). Outmigration starts in late May and early June and extends throughout the summer with older age groups typically outmigrating earlier than younger age groups. Booth (*in preparation*) documented a longer outmigration period on the Moose River and a shorter outmigration period occurs in Hidden Creek (Todd and Kyle 1987).

Age, length, and weight.-Outmigrant sockeye salmon captured in the inclined plane trap were primarily age 1 fish (70.5%). This figure is substantially higher than the proportion of adults sampled that spent one year in fresh water (37%). Possible explanations for this

discrepancy include: 1) capture efficiency of the inclined plane trap varies for different age groups; 2) adult and juvenile fish sampled for age were not a true random sample; or, 3) a shift in age structure of outmigrants is occurring. Like the Swanson River, sockeye salmon in the Kasilof River drainage outmigrate primarily as age 1 fish (Koenings et al. 1986). In contrast, 79% of the sockeye salmon in the Moose River outmigrated as age 0 fish (Booth *in preparation*). Mean lengths at age of juvenile sockeye salmon in the Swanson River are similar to those in the Moose River.

Over 90% of the coho salmon in the Swanson River outmigrated as age 2 and age 3 fish. This is higher than the proportion of adults sampled that spent two or three years in fresh water (75% in 1988 and 73% in 1989). Possible explanations for this observed discrepancy include the reasons mentioned above for sockeye salmon. Unlike the Swanson River, coho salmon in the Moose River outmigrate primarily as age 0 fish (Booth *in preparation*). Several researchers have suggested that the outmigration of young of the year fish is a seasonal movement caused by water velocity or density dependent mechanisms and is not necessarily a smoltification (Hoar 1958; Chapman 1962; Hartman et al. 1982; Elliot and Finn 1984). The dominance of age 2.1 and 3.1 adult coho salmon in the Moose River supports this hypothesis. Mean lengths at age of juvenile coho salmon in the Swanson River are similar to those in the Moose River.

Management Implications

Observations made during this survey indicate that escapements of coho salmon in the Swanson River drainage during 1988 and 1989 were much larger than returns observed in the 1960's. Escapements exceeded 20,000 fish annually during these two years. An increase in angler effort was observed during 1988 and 1989 in response to the large numbers of fish returning to the Swanson River. Mills (1989, 1990) reported over 6,000 coho salmon harvested annually during 1988 and 1989 compared to an average of about 1,200 fish annually during 1990 and 1991. The decrease in numbers of coho salmon harvested during 1990 and 1991 may be related to lower escapements, but may also be related to the lack of a weir. The presence of the weir during 1988 and 1989 substantially increased fishing effort in the lower Swanson River. The weir was a natural attraction for anglers and visitors because it provided an excellent viewing area where people could observe hundreds of salmon migrating upstream. The weir also acted as a barrier which slowed migration and concentrated fish in the lower stretch of river.

To determine the relative strength of coho salmon returns to the Swanson River in future years, escapement monitoring should be conducted annually in Sucker and Gruska creeks. Three or four survey counts during the peak spawning period will provide an index of run strength and will alert managers to potential impacts from public use and encroaching development.

Acknowledgements

We express our appreciation to all those people who contributed to this project: co-workers Jeff Booth, Mary Faurot, Gerry Gray, Jim Lazar and Ted Otis; Student Conservation Volunteers Ken Bosse, Dana Bruden, Sym Colovos, Dan Epstein, Rick Hurst, Vincent Lofaro, Michelle Link, Jeff Melegari, Art Schaub, John Tobin, and Shannon Winters; U.S. Fish and Wildlife Service volunteers Jack Dean, Bob Harned, Todd Mabee, Bob Murray, R.D. Nelle and Rob Steinmetz; Kenai National Wildlife Refuge pilots Bill Larned and Rick Johnston; and our office secretary Anne Barrett who typed this manuscript.

We also appreciate the support and cooperation of the Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation.

References

Alaska Department of Fish and Game. 1983. Anadromous waters catalog. Habitat Division, Juneau, Alaska.

Ambrose, J. 1983. Age determination. Pages 301-324 *in* L.A. Nielsen and D.L. Johnson, editors. Fisheries Techniques. American Fisheries Society, Bethesda, Maryland.

Ames, J. 1984. Puget Sound chum salmon escapement estimates using spawner curve methodology. Pages 135-148 *in* P.E.K. Symons and M. Waldichuk, editors. Proceedings of the workshop on stream indexing for salmon escapement. Canadian Technical Report of Fisheries and Aquatic Sciences Number 1326, West Vancouver, British Columbia.

Booth, J.A. *In Preparation.* Fishery investigation of the Moose River, Kenai National Wildlife Refuge, Alaska, 1985 and 1986. U.S. Fish Wildlife Service, Alaska Fisheries Technical Report, Kenai, Alaska.

Chapman, D.W. 1962. Aggressive behavior in juvenile coho salmon as a cause of emigration. Journal of the Fisheries Research Board of Canada 19:1047-1080.

Cousens, N.B.F, G.A. Thomas, C.G. Swan, and M.C. Healey. 1982. A review of salmon escapement estimation techniques. Canadian Technical Report of Fisheries and Aquatic Sciences Number 1108.

Crone, R.D. and C.E. Bond. 1976. Life history of coho salmon *Oncorhynchus kisutch*, in Sashin Creek, Southeast Alaska. Fisheries Bulletin 74:897-923.

Elliot, G.V. and J.E. Finn. 1984. Fish use of several tributaries to the Kenai River, Alaska. Final Report. U.S. Fish and Wildlife Service, Anchorage, Alaska.

Engel, L. 1966. Egg take investigation in Cook Inlet drainage and Prince William Sound. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Report of Progress, 1965-1966, Juneau, Alaska.

Engel, L. 1967. Egg take investigation in Cook Inlet drainage and Prince William Sound. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Report of Progress, 1966-1967, Juneau, Alaska.

Engel, L. 1968. Inventory and cataloging of the sport fish and waters in the Kenai, Cook Inlet-Prince William Sound areas. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Report of Progress, 1967-1968, Juneau, Alaska.

Faurot, D. and J. Dean. *In Preparation*. Chickaloon River basin fishery survey, Kenai National Wildlife Refuge, 1984-1985. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report, Kenai, Alaska.

Flagg, L.B., P. Shields, and D.C. Waite. 1985. Sockeye salmon smolt studies, Kasilof River, Alaska, 1984. Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Enhancement, and Development, Report 47, Juneau, Alaska.

Hammarstrom S.L. and D.E. Athons. 1989. Catch and effort statistics for the sockeye salmon sport fishery in the Russian River with estimates of escapement, 1988. Alaska Department of Fish and Game, Division of Sport Fish, Fishery Data Series Number 88. Juneau, Alaska.

Hartman, G.F., B.C. Anderson, and J.C. Scrivener. 1982. Seaward movement of coho salmon *Oncorhynchus kisutch* fry in Carnation Creek, an unstable stream in British Columbia. Canadian Journal of Fisheries and Aquatic Science 39:588-597.

Hoar, W.S. 1958. The evolution of migratory behavior among juvenile salmon of the genus *Oncorhynchus*. Journal of the Fisheries Research Board of Canada 15:391-428.

Inghram, M. and R. Ireland. 1990. Kenai Peninsula streamflow data, 1989. Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys, Public-Data File 90-3, Fairbanks, Alaska.

Jackson, M. 1983. Eshamy Weir Reconstruction. Alaska Department of Fish and Game, Memorandum, Cordova, Alaska.

Karlstrom, T.N.V. 1964. Quarternary geology of the Kenai Lowland and glacial history of Cook Inlet region, Alaska. U.S. Geological Survey, Professional Paper 443, Washington, D.C.

King, B.E. and K.E. Tarbox. 1989. Upper Cook Inlet salmon escapement studies, 1988. Alaska Department of Fish and Game, Division of Commercial Fisheries Technical Fishery Report Number 89-19, Juneau, Alaska.

Koenings, J.P., R.D. Burkett, G.B. Kyle, J.A. Edmundson, and J.M. Edmundson. 1986. Trophic level responses to glacial meltwater intrusion in Alaskan lakes. Pages 179-194 *in* D.L. Kane, Editor. Proceedings of the Symposium: Cold Regions Hydrology. University of Alaska, Fairbanks, Alaska.

Koo, T. 1962. Age designation in salmon. Pages 37-48 *in* T.S.K. Koo, editor. Studies of Alaska red salmon. University of Washington Press, Seattle, Washington.

Lawler, R.F. 1963. Silver salmon egg taking investigations in Cook Inlet drainage. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Report of Progress, 1962-1963, Juneau, Alaska.

Logan, S.M. 1970. Inventory and cataloging of Kenai Peninsula - Cook Inlet - Prince William Sound drainages and fish stocks. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Report of Progress, 1969-1970, Juneau, Alaska.

Mills, M.J. 1984. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Juneau, Alaska.

Mills, M.J. 1985. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1984-1985, Juneau, Alaska.

Mills, M.J. 1986. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Juneau, Alaska.

Mills, M.J. 1987. Alaska statewide sport fisheries harvest report. Alaska Department of Fish and Game, Fishery Data Series Number 2, Juneau, Alaska.

Mills, M.J. 1988. Alaska statewide sport fisheries harvest report. Alaska Department of Fish and Game, Fishery Data Series Number 52, Juneau, Alaska.

Mills, M.J. 1989. Alaska statewide sport fisheries harvest report. Alaska Department of Fish and Game, Fishery Data Series Number 122, Juneau, Alaska.

Mills, M.J. 1990. Harvest and participation in Alaska sport fisheries during 1989. Alaska Department of Fish and Game, Fishery Data Series Number 90-44, Anchorage, Alaska.

Mills, M.J. 1991. Harvest, catch, and participation in Alaska sport fisheries during 1990. Alaska Department of Fish and Game, Fishery Data Series Number 91-58, Anchorage, Alaska.

Nelson, D., D. Athons, and J. Carlon. 1987. Russian River sockeye salmon study. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Progress Report, 1985-1986, Juneau, Alaska.

Ruesch, P.H. 1991. Upper Cook Inlet commercial fisheries annual management report, 1990. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report Number 2S91-1, Soldotna, Alaska.

Todd, G.L. and G.B. Kyle. 1987. Hidden Lake Report, 1987. Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Enhancement and Development. Juneau, Alaska.

U.S. Fish and Wildlife Service. 1985. Kenai National Wildlife Refuge final comprehensive conservation plan, environmental impact statement, and wilderness review. Anchorage, Alaska.

APPENDIX 1.-Daily counts of anadromous and resident fish species at the Swanson River weir, Alaska, 1988 and 1989.

Date	Species						
	Coho salmon	Sockeye salmon	Chinook salmon	Pink salmon	Rainbow trout	Dolly Varden	Longnose sucker
				1988			
May							
21	0	0	0	0	0	0	0
22	0	0	0	0	1	0	0
23	0	0	0	0	2	0	0
24	0	0	0	0	2	0	0
25	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0
27	0	0	0	0	1	0	0
28	0	0	0	0	1	0	0
29	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0
31	0	0	0	0	3	0	0
June							
1	0	0	0	0	1	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	3	0	0
4	0	1	0	0	0	0	1
5	0	0	0	0	0	0	1
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	1	0	0
10	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0
12	0	20	0	0	0	0	0
13	0	6	0	0	0	0	0
14	0	2	0	0	0	0	0
15	0	5	0	0	0	0	1
16	0	15	0	0	0	0	0
17	0	16	0	0	0	0	0
18	0	6	0	0	0	0	0
19	0	5	0	0	0	0	0
20	0	8	0	0	0	0	0
21	0	20	0	0	0	0	0
22	0	48	0	0	0	0	0
23	0	15	0	0	0	0	0
24	0	5	0	0	0	0	0
25	0	143	0	0	0	1	0
26	0	30	0	0	0	0	0
27	0	2	1	0	0	0	0
28	0	0	1	0	0	0	0
29	0	20	2	0	0	0	0
30	0	8	1	0	0	0	0

APPENDIX 1.-(Continued).

Date	Species						
	Coho salmon	Sockeye salmon	Chinook salmon	Pink salmon	Rainbow trout	Dolly Varden	Longnose sucker
July							
1	0	14	0	0	0	0	0
2	0	0	0	0	10	0	0
3	0	5	0	0	0	0	0
4	0	1	0	0	0	0	0
5	0	7	0	0	0	0	0
6	0	1	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	2	0	0	0	0	0
10	0	15	0	0	0	0	0
11	0	13	0	0	0	0	1
12	0	13	0	0	0	0	0
13	0	1	0	0	0	0	0
14	0	7	0	0	0	0	0
15	0	6	0	0	0	0	0
16	1	9	0	0	0	1	0
17	0	6	0	0	0	0	0
18	0	4	0	0	0	0	0
19	0	12	0	0	0	0	0
20	0	7	0	0	0	1	0
21	0	16	0	0	0	0	0
22	1	42	0	0	0	0	0
23	3	78	0	0	0	0	0
24	3	24	0	0	0	0	0
25	17	29	0	0	0	0	0
26	10	28	0	0	0	0	0
27	22	25	0	0	0	0	0
28	29	27	0	0	0	0	0
29	34	37	0	0	0	0	0
30	29	47	0	0	0	0	0
31	25	43	0	0	0	0	0
August							
1	27	31	0	0	0	0	0
2	80	58	0	0	0	0	0
3	46	45	0	0	0	0	1
4	85	57	0	3	0	0	0
5	100	52	0	3	0	0	0
6	272	76	0	2	0	0	0
7	240	72	0	9	0	0	0
8	379	39	0	8	0	0	0
9	165	16	0	0	0	0	0
10	235	9	0	3	0	0	0
11	409	22	0	7	0	0	0

APPENDIX 1.-(Continued).

Date	Species						
	Coho salmon	Sockeye salmon	Chinook salmon	Pink salmon	Rainbow trout	Dolly Varden	Longnose sucker
12	769	17	0	3	0	0	0
13	658	15	0	3	0	0	0
14	508	13	0	2	0	0	0
15	654	10	0	0	0	0	0
16	672	5	0	0	0	0	0
17	685	4	0	3	0	0	0
18	1,789	13	0	6	0	0	0
19	563	3	0	3	0	0	0
20	632	7	0	3	0	0	0
21	1,322	5	0	1	0	0	0
22	1,907	3	0	1	0	0	0
23	899	16	0	4	0	0	0
24	1,564	9	0	3	0	0	0
25	842	3	0	2	0	0	0
26	1,689	4	0	2	0	0	0
27	439	3	0	0	0	0	0
28	288	1	0	0	0	0	0
29	554	1	0	0	0	0	0
30	381	0	0	1	0	0	0
31	271	11	0	0	0	0	0
September							
1	977	3	0	0	0	0	0
2	497	0	0	0	0	0	0
3	576	4	0	0	0	0	0
4	94	2	0	0	0	0	0
5	129	2	0	0	0	0	0
6	345	0	0	0	0	0	0
7	71	0	0	0	0	0	0
8	244	1	0	0	0	0	0
9	163	1	0	0	0	0	0
10	252	0	0	0	0	0	0
11	92	0	0	0	0	0	0
12	181	1	0	0	0	0	0
13	77	1	0	0	0	0	0
14	275	0	0	0	0	0	0
15	44	0	0	0	0	0	0
16	17	2	0	0	0	0	0
17	24	0	0	0	0	0	0
18	12	0	0	0	0	0	0
19	13	0	0	0	0	0	0
20	33	0	0	0	0	0	0
21	36	0	0	0	0	0	0
22	20	1	0	0	0	0	0

APPENDIX 1.-(Continued).

Date	Species						
	Coho salmon	Sockeye salmon	Chinook salmon	Pink salmon	Rainbow trout	Dolly Varden	Longnose sucker
23	19	0	0	0	0	0	0
24	13	0	0	0	0	0	0
25	5	0	0	0	0	0	0
26	7	0	0	0	0	0	0
TOTAL 1988	23,514	1,542	5	72	15	3	5
			1989				
July							
28	0						
29	0						
30	1						
31	0						
August							
1	1						
2	4						
3	8						
4	13						
5	6						
6	22						
7	17						
8	41						
9	180						
10	656						
11	493						
12	263						
13	469						
14	520						
15	379						
16	517						
17	741						
18	1,233						
19	859						
20	1,149						
21	1,431						
22	2,892						
23	2,006						
24	720						
25	2,472						
26	1,540						
27	2,208						
TOTAL 1989	20,841						

APPENDIX 2.-Number of live and dead coho and sockeye salmon counted in the inlets and outlets of various lakes in the Swanson River watershed, Alaska, 1988.

Stream[a]	Date	Coho		Sockeye	
		Live	Dead	Live	Dead
Berry Lake	September 22	0	0	0	0
Breeze Lake	September 20	0	0	0	0
Campers Lake	September 22	0	0	0	0
Campfire Lake					
Inlet	September 28	0	0	0	0
Outlet	September 28	5	0	0	1
Canoe Lake	October 3	0	0	0	0
	October 20	5	1	0	0
Canoe Lake 1	October 3	2	5	0	0
	October 20	60	15	0	0
Canoe Lake 2	October 3	0	4	0	0
	October 20	42	29	0	0
Contact Lake	October 3	0	0	0	0
	October 20	40	5	0	0
Crane Lake	October 19	2	0	0	0
Doghouse Lake	September 27	0	0	0	0
	October 7	368	19	0	0
	October 14	0	0	0	0
	October 17	8	35	0	0
Dolly Varden					
Lake	August 8	0	0	0	0
Gene Lake					
Inlet	October 5	2000	10	0	0
Outlet	October 5	0	0	0	0
Gruska Lake	August 8	0	0	0	0
	September 19	189	0	3	0
	September 29	270	50	0	0
	October 11	1234	24	0	0
	October 28	270	895	0	0
	November 7	148	476	0	0
	November 18	outlet frozen - no survey			
	November 29	outlet frozen - no survey			
Hat Lake	September 21	0	0	0	0
Hungry Lake	September 20	0	0	0	0
Leaf Lake	September 21	0	0	0	0
Lo Lake	September 21	0	0	0	0
Lonely Lake	September 21	0	0	0	0
Lure Lake					
Inlet	September 21	0	0	0	0
Outlet	September 21	0	0	0	0
Martin Lake	October 3	0	0	0	0
	October 20	ice encountered			

APPENDIX 2.-(Continued).

Stream[a]	Date	Coho		Sockeye	
		Live	Dead	Live	Dead
McLain Lake	October 6	165	0	0	0
Merganser Lake	September 29	1	0	0	0
	October 14	86	10	0	0
Mink Lake	July 28	0	0	0	0
	September 20	0	0	0	0
	September 29	0	0	0	0
Mouse Lake	September 21	0	0	0	0
Paddle Lake	September 21	0	0	0	0
Pan Lake	September 21	0	0	0	0
Pot Lake	September 21	0	0	0	0
Rainbow Lake	September 8	0	0	0	0
	October 14	0	0	0	0
Redpoll Lake					
Inlet	September 22	0	0	0	0
Outlet	September 22	0	0	0	0
Rodent Lake					
Inlet	September 21	0	0	0	0
Outlet	September 21	0	0	0	0
Snipe Lake	October 19	30	1	0	0
Spruce Lake	October 3	0	0	0	0
	October 20	ice encountered			
Stormy Lake	June 10	0	0	0	0
	August 18	0	0	0	0
Sucker Lake	August 2	0	0	0	0
	August 9	0	0	0	0
	September 19	178	0	0	0
	September 29	352	100	0	0
	October 11	929	182	0	0
	October 28	358	315	0	0
	November 7	306	611	0	0
	November 18	249	233	0	0
	November 29	116	190	0	0
	December 9	47	110	0	0
Swan Creek	August 9	0	0	0	0
	August 27	78	1	0	0
	October 7	195	8	0	0
	October 17	35	3	0	0
Swanson Lake	September 22	0	0	0	0
Swanson River	July 26	0	0	35	0
Oil Field	July 28	0	0	130	2
Bridges	August 2	0	0	54	3
	August 10	3	0	15	30
	October 14	0	0	0	0
Wild Lake	October 6	25	0	0	0
Wilderness Lake	September 15	0	0	2	0

[a] Refers to outlet unless otherwise stated.

APPENDIX 3.-Daily inclined plane trap catch of coho salmon (SS), sockeye salmon (RS), chinook salmon (KS), rainbow trout (RB), slimy sculpin (CN), coastrange sculpin (CR), longnose sucker (LS), Pacific lamprey (PL), eulachon (EU), ninespine stickleback (S9), threespine stickleback (SB), Arctic lamprey (AL), and Dolly Varden (DV) in the Swanson River, Alaska, 1988.

	Species												
Date	SS	RS	KS	RB	CN	CR	LS	PL	EU	S9	SB	AL	DV
May													
21	0	1	0	0	4	0	0	0	0	2	2	0	0
22	0	1	0	0	0	0	0	0	0	0	0	0	0
23	0	2	0	0	2	0	0	0	0	1	3	0	0
24	0	0	0	0	0	0	0	0	0	1	0	0	0
25	0	2	0	0	1	0	0	0	0	0	3	0	0
26	1	1	0	0	2	0	0	0	0	0	0	0	0
27	0	1	0	0	0	0	0	0	0	0	0	0	0
28	0	1	0	0	0	0	0	0	0	1	0	0	0
29	0	1	0	1	1	0	0	0	0	0	1	1	0
30	0	3	0	0	2	0	0	0	0	0	2	0	0
31	49	3	0	0	1	0	0	0	0	0	0	0	0
June													
1	206	42	0	3	0	0	0	0	0	0	0	0	0
2	98	20	0	2	6	0	0	0	0	0	0	0	0
3	25	20	0	0	1	0	0	0	0	0	1	0	0
4	56	14	0	2	2	0	0	0	0	0	0	0	0
5	84	16	0	2	3	0	0	0	0	1	2	2	0
6	54	19	0	0	1	0	0	0	0	0	0	11	0
7	152	58	0	1	1	0	0	0	0	0	0	6	0
8	71	63	0	2	1	0	0	0	0	0	0	7	0
9	97	102	0	0	0	0	0	0	1	1	2	14	0
10	16	33	0	0	0	0	0	0	0	0	1	36	0
11	29	37	0	0	0	0	0	0	0	0	0	20	0
12	15	43	0	0	1	0	0	0	0	0	0	25	0
13	5	12	0	0	7	0	0	0	0	0	1	0	0
14	3	4	0	0	0	0	0	0	0	0	0	10	0
15	2	9	0	0	0	0	0	0	0	0	0	11	0
16	4	14	0	0	1	0	0	0	0	0	1	9	0
17	1	0	0	0	0	0	0	0	0	0	3	6	0
18	6	5	0	0	0	0	0	0	0	0	0	4	0
19	1	3	0	0	0	0	0	0	0	0	1	8	0
20	1	22	0	2	0	0	0	0	0	0	0	1	0
21	11	50	0	22	1	0	0	0	0	0	0	3	0
22	1	75	0	18	1	0	0	0	0	0	1	1	0
23	5	149	0	30	0	0	0	0	0	0	0	6	0
24	1	148	0	62	0	0	0	0	0	0	0	3	0

APPENDIX 3.-(Continued).

Date	Species												
	SS	RS	KS	RB	CN	CR	LS	PL	EU	S9	SB	AL	DV
June													
25	0	106	0	76	0	0	0	0	0	0	0	0	0
26	0	291	0	20	1	0	0	0	0	0	0	2	0
27	0	347	0	46	0	0	0	0	0	0	0	0	0
28	1	98	0	3	0	0	0	0	0	0	2	1	1
29	3	148	0	0	0	0	0	0	0	0	3	0	0
30	0	174	0	6	0	0	0	0	0	0	0	0	0
July													
1	0	84	0	0	0	0	0	0	0	0	0	0	0
2	3	64	0	4	0	0	0	0	0	0	0	0	0
3	0	53	0	6	0	0	0	0	0	0	0	0	0
4	0	87	0	2	0	0	0	0	0	0	0	3	0
5	1	73	0	2	0	0	0	0	0	0	0	0	0
6	1	46	0	1	0	0	0	0	0	0	0	0	0
7	1	69	0	0	0	0	0	0	0	0	0	0	0
8	1	20	0	1	0	0	0	0	0	1	0	1	0
9	1	18	0	2	0	0	0	0	0	1	1	0	0
10	0	27	0	5	1	0	0	0	0	0	2	1	0
11	0	29	0	4	0	0	0	0	0	0	0	1	0
12	0	52	0	4	1	0	0	0	0	0	1	0	1
13	0	24	0	1	0	0	0	0	0	0	0	0	0
14	2	15	0	0	0	0	0	0	0	0	0	0	0
15	2	9	0	0	0	0	0	0	0	0	1	0	0
16	0	17	0	0	2	0	0	0	0	0	0	0	0
17	3	39	0	0	2	0	0	0	0	0	0	1	0
18	1	15	0	1	2	0	0	0	0	0	0	0	0
19	2	27	0	2	3	0	0	0	0	0	2	0	0
20	2	34	1	2	1	0	0	0	0	0	0	0	0
21	4	27	0	6	2	0	0	0	0	0	2	0	0
22	4	14	0	0	10	0	0	0	0	0	0	1	0
23	2	15	0	3	5	0	0	0	0	0	1	1	0
24	3	29	0	7	4	0	0	0	0	0	3	1	0
25	3	17	1	6	2	0	0	0	0	0	12	0	0
26	1	16	0	7	10	0	0	0	0	0	22	0	0
27	2	16	0	7	5	0	0	0	0	0	6	0	0
28	1	15	0	8	17	0	0	0	0	0	10	0	0
29	1	10	0	2	4	0	0	0	0	0	7	0	0
30	2	4	0	3	4	0	0	0	0	0	7	0	1
31	3	19	0	8	0	0	0	0	0	0	0	0	0
August													
1	1	9	0	4	9	0	0	0	0	0	5	0	0
2	1	13	1	6	24	0	0	0	0	0	4	0	0

APPENDIX 3.-(Continued).

Date	Species												
	SS	RS	KS	RB	CN	CR	LS	PL	EU	S9	SB	AL	DV
August													
3	0	6	0	2	7	0	0	0	0	1	47[a]	0	0
4	5	6	0	6	11	0	0	0	0	0	193[a]	0	0
5	2	7	0	10	10	0	0	0	0	0	108[a]	0	0
6	1	8	0	17	6	0	0	0	0	0	72[a]	0	0
7	3	11	0	96	2	0	0	0	0	0	300[a]	0	0
8	2	9	0	30	9	0	0	0	0	0	1750[a]	1	0
9	0	5	0	6	1	0	0	0	0	0	600[a]	0	0
10	1	5	0	8	8	0	0	0	0	0	260[a]	0	0
August 11 to September 17	Discontinued												
September													
18	1	0	0	0	1	1	0	0	0	1	48	0	0
19	2	0	0	0	7	0	0	0	0	2	80	0	0
20	1	1	0	1	13	0	0	1	0	1	65	0	0
21	0	0	0	1	0	1	0	0	0	0	3	0	0
22	0	0	0	0	0	2	1	0	0	0	28	0	0
23	0	2	0	0	0	4	2	1	0	3	50	0	0
Total	1,064	3,204	3	579	223	8	3	2	1	17	3,719	198	3

[a] Includes the anadromous form of threespine stickleback.